



**Spatial Strategic Interaction among Local Governments: Evidence  
from the Portuguese Personal Income Tax**

by

Diogo Fernandes Amador Costa Tomé

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School of Economics and Management, University of Porto

Supervised by:

Maria Manuel Pinho

Ana Paula Ribeiro

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## **Biographical note**

Diogo Tomé was born in Porto, Portugal on 21 October 1993. In 2015, he graduated in Economics from the School of Economics and Management of the University of Porto.

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## Abstract

The present study assesses the existence of fiscal strategic interactions between Portuguese municipalities for the Personal Income Tax's variable participation rate. With fiscal decentralization at the centre of the current Portuguese policy agenda, understanding whether strategic interactions are a real phenomenon is not only of academic interest but can also help design a better institutional framework. Our study uses panel data for all the 278 municipalities of mainland Portugal, covering the period 2008–2015. The analysis of Moran's I statistic provides some evidence of neighbourhood effects. To test whether the detected neighbourhood effects can be attributed to strategic interactions, we estimate five spatial panel data models using the quasi-maximum likelihood method. There is little evidence that strategic interactions in the participation rates occur among Portuguese municipalities. We find a positive and statistically significant spatial dependence parameter in only one of the spatial panel models considered.

JEL Codes: C23; H71; H73

Keywords: Strategic interaction; Spatial panel data models; Local governments; Portugal

## Resumo

Este estudo analisa a existência de interações estratégicas fiscais entre os municípios portugueses, no caso da taxa de participação variável no Imposto sobre o Rendimento das Pessoas Singulares (IRS). Com a descentralização orçamental no centro da agenda política portuguesa atual, perceber se as interações estratégicas são um fenómeno real não é apenas de interesse académico, na medida em que também pode ajudar no desenho de um quadro institucional mais adequado. O estudo utiliza dados em painel para os 278 municípios do continente português, cobrindo o período 2008-2015. A análise da estatística I de Moran fornece alguma evidência de efeitos de vizinhança. Para testar se os efeitos de vizinhança detetados podem ser atribuídos a interações estratégicas, procedeu-se à estimação de cinco modelos espaciais de dados em painel, aplicando o método de quase-máxima verossimilhança. Existe pouca evidência de interações estratégicas nas taxas de participação entre os municípios portugueses. Encontrou-se um parâmetro de dependência espacial positivo e estatisticamente significativo em apenas um dos modelos espaciais de dados em painel considerados.

Códigos JEL: C23; H71; H73

Palavras-chave: Interação estratégica; Modelos espaciais de dados em painel; Municípios; Portugal

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## Introduction

With the development of spatial econometrics, an increasing number of empirical studies have tested for strategic interaction among local jurisdictions of different countries over the last two decades. This has provided an assessment of different types of spatial-dependent behaviour in local public finances: expenditure spillovers, tax and welfare competition and yardstick competition.

Fiscal spatial interaction among municipalities is a very recent research theme in Portugal, and thus still with very few studies: to the best of our knowledge, there are only three papers covering strategic interaction on the revenue side – Coimbra et al. (2011), Costa et al. (2011) and Costa and Carvalho (2013) – and three other assessing it on the expenditure side – Barreira (2010), Barreira (2011) and Costa et al. (2015).

From 2007 onwards, the Portuguese municipalities were given the ability to decide to return to their taxpayers up to 5% of the Personal Income Tax collected. Only two studies – Coimbra et al. (2011) and Costa et al. (2011) – have tested for spatial interactions regarding this local public revenue, using cross-sectional data for the year 2009. The empirical results for the variable participation rate in the Personal Income Tax were unstable and partially inconclusive. The authors believe the results may have been influenced not only by the small amplitude of the rate variable, but also because, in 2009, strategic interaction concerning this rate was still unlikely to emerge. We intend to contribute to close this gap, taking advantage of an increased variability in time, using panel data for the 2008–2015 period for all the 278 mainland Portuguese municipalities.

Our objective is to assess the existence of fiscal strategic interactions among Portuguese municipalities regarding the variable participation rate in the Personal Income Tax. Based on the explanations of strategic interaction offered in the literature – expenditure spillovers, yardstick competition and tax/welfare competition –, we attempt to identify the most likely driver of that potential interaction. With fiscal decentralization at the centre of the current Portuguese policy agenda, understanding whether strategic interaction is a real phenomenon is not only of academic interest, but can also help reformists in designing a better institutional framework. We believe this gives our study additional relevance.

The study is organized in six sections. After the Introduction, Chapter 1 presents a brief overview of the literature on horizontal strategic interaction among local governments. The theoretical framework is based on the “spillover” and “resource-flow” models. These two broad categories of models capture the main theories that explain strategic interactions: expenditure spillovers, tax/welfare competition and yardstick competition. We describe each of the theories separately. Lastly, we present the state of the art of the empirical studies, focusing mainly on the revenue side.

Chapter 2 presents an overview of the Portuguese institutional framework. The local government unit on which we focus is the municipality. We briefly describe the decentralization path that has been followed since democracy was re-established in 1974. In particular, we highlight the previous and most recent Local Finance Laws (the Law 2/2007, January 15<sup>th</sup>, and the current Law 73/2013, September 3<sup>rd</sup>), which gave municipalities the ability to decide the participation rate in the Personal Income Tax (the strategic variable of our study), and its predicted effects: an increase in inter-municipal tax competition and in the local political accountability on the revenue side. We discuss the current financial state of municipalities; despite the noticeable increase in discretionary power on the revenue side, municipalities still depend mainly on transfers from the central government to fund their expenditures. We enumerate the current fiscal competences of the Portuguese municipalities and explain how the Portuguese local elections work. Within the Portuguese institutional framework, we present the case for why we believe the yardstick competition hypothesis to have, *a priori*, the most explanatory power in the case of our strategic variable of choice.

In Chapter 3, we present a summary of the standard methodology used to assess horizontal spatial strategic interactions in local public finances. This includes the presentation of the general form of the econometric model, of the criteria for the definition of neighbourhood (we discuss the spatial weights matrix to be used in the study) and of some model limitations that the estimation strategy has to overcome. We present the case for using panel data, the spatial panel data models to be estimated, and the estimation strategy: the Quasi-Maximum Likelihood (QML) method.

In Chapter 4, we start with a preliminary spatial analysis by exploring the Moran's I and LISA statistics. We present the data and the descriptive statistics for the variables

used in the study and the analyses of the empirical results obtained from the estimation of the spatial panel data models.

Finally, in the last section, we present the main conclusions.

## Chapter 1. Theoretical framework

Horizontal strategic interaction between local governments is based on the idea that jurisdictions do not act in isolation. Jurisdictions may be significantly influenced and may react to the policies taken by neighbouring jurisdictions. Simply put, strategic interaction occurs when there is a correlation between the variance of tax rates or expenditure levels of local jurisdictions which is driven by strategic considerations (i.e., excluding the effects of common unobserved shocks following a spatial pattern).

In order to empirically assess strategic interaction, most studies estimate a reaction function in which the value of a strategic fiscal policy variable in a jurisdiction is a function of spatially weighted decisions of neighbouring jurisdictions (Lyytikäinen, 2012). Generally, when the slope of the reaction function – which measures how a change in the fiscal variable in a neighbouring jurisdiction influences the jurisdiction's own variable (Sedmíhradská, 2013) – is significantly different from zero, we are in the presence of strategic interaction for that strategic fiscal policy variable.

The reaction function captures the main theories for explaining strategic interaction among local governments based on two broad categories of models: the spillover models and the resource-flow models (Brueckner, 2003).

Spillover models rely on the assumption that each jurisdiction decides on the level of a strategic policy variable, but the jurisdiction is also directly affected by the decisions of neighbouring jurisdictions concerning that variable, which means that neighbouring decisions have spillover effects on the decisions of a given local government (Brueckner and Saavedra, 2001; Brueckner, 2003; Costa et al., 2011).

In resource-flow models, decisions on a strategic fiscal policy variable affect the flow of resources between jurisdictions. Since the availability of local resources is finite, its distribution among jurisdictions depends, directly, on the decisions of each jurisdiction and, indirectly, on the decisions of the surrounding jurisdictions to attract those resources. In other words, when deciding on a strategic variable, jurisdictions are not directly influenced by the decisions concerning this variable in the neighbouring jurisdictions, but are indirectly affected by the amount of resources available in the neighbouring jurisdictions, which leads to strategic behaviour (Brueckner and Saavedra, 2001, Brueckner, 2003; Costa et al., 2011).

Within the theoretical explanations of strategic interaction, expenditure spillovers and yardstick competition models rely on spillover models, while tax and welfare competition fundamentals are captured by resource-flow models.

In this chapter, we present the state of the art of the theoretical explanations of strategic interactions, as well as an overview of the empirical studies published in this field, both abroad and in Portugal.

## **1.1. The explanations of strategic interaction**

In this section we explore the theoretical explanations of strategic interactions found in the literature.

### ***Expenditure spillovers***

The first explanation brought forward to explain strategic interactions relying on spillover models is that of expenditure spillovers, which arise from public expenditures on local public goods and services which can have beneficial or detrimental (spillover) effects on the welfare of residents in nearby jurisdictions (Revelli, 2002).

If a jurisdiction decides on increasing the expenditure of complementary (competing) local public goods, such as, e.g., roads (schools), neighbouring municipalities are likely to boost (constrain) their own expenditures to overcome (take advantage of) the negative (positive) spillover effects. Thus, the optimal level of expenditure in each jurisdiction depends on the expenditure decisions in neighbouring jurisdictions (Geys, 2006).

Moreover, since expenditure levels may be spatially correlated among jurisdictions, the same will hold for tax rates (Allers and Elhorst, 2005). When a public good provided by a neighbouring jurisdiction has benefits in a certain jurisdiction, the latter may be able to provide less of that good, which requires lower financial needs. Thus, the presence of positive (negative) spillovers can also lead to negative (positive) interactions in tax rates (Baskaran, 2014).

### *Yardstick competition*

The second explanation of strategic interaction that falls into spillover models, incidentally the most recent explanation offered in the local public finance literature, is yardstick competition. Under yardstick competition, first expressed by Shleifer (1985) and Salmon (1987), later explored by Case et al. (1993) and modelled by Besley and Case (1995), fiscal interactions arise from a political agency problem between local politicians and their constituency.

This hypothesis explains fiscal interactions without invoking the concept of mobility of the tax base, through what Allers and Elhorst (2005:1) call the “vote mechanism”. Jurisdictions compete for votes in the political market.

Yardstick competition derives from the benefit spillover model as a form of informational externality/spillover. The framework assumes imperfect and asymmetric information between voters and local politicians. Unlike policy authorities, voters do not have complete information on how many public goods and services can be provided with a certain level of tax rates. There are two types of local politicians: good, non rent-seeking, politicians and bad, rent-seeking, politicians. The latter try to finance their whims at taxpayers’ expenses (Besley and Case, 1995). Such selfish and opportunistic behaviour generates incentives to prevent relevant information from being fully available to their constituencies, so they can more easily raise tax rates to collect more revenue than that needed to finance the optimal level of local public goods; thus, extra tax revenue is used as political rents for their own benefit. The political agency problem arises because voters do not clearly distinguish between the two types of politicians.

Under such circumstances, voters have the possibility, through the media or other sources of information, to use the fiscal situation of neighbouring jurisdictions as yardsticks to compare and appraise their own local incumbents’ relative performance, thus being able to reduce informational problems they are confronted with as well as to circumvent and overcome the political agency problems (Salmon, 1987; Schaltegger and Küttel, 2002). In other words, voters use information from neighbouring jurisdictions’ tax rates and expenditure levels as a benchmark for them to assess the costs and suitability of their own jurisdiction’s policies (Shleifer, 1985; Besley and Case, 1995; Allers and Elhorst, 2005).

In a representative democracy, if voters are indeed aware and sensitive to events outside their immediate jurisdictions (as is assumed by the yardstick competition hypothesis), they can use this simple strategy, which enables a more accurate judgment of their local politician's behaviour.

Neighbouring jurisdictions' choices provide, therefore, a positive informational externality (Bordignon et al., 2003), helping voters to discriminate between the two different types of politicians. The citizens' ability to use information from neighbouring jurisdictions improves the quality assessment of their own jurisdiction (voters can better judge if their political representatives are rent-seeking or not). Because the yardstick mechanism is likely to increase political accountability, it can be seen as an additional argument in favour of decentralization (Sedmíhradská, 2013).

A bad relative performance by local politicians will penalize their chances of re-election, thus decreasing the incentives for fiscal exploitation by rent-seeking politicians (Heyndels and Vuchelen, 1998). Consequently, incumbents are compelled to look at the taxation behaviour of neighbouring local politicians and align their taxes to avoid being punished at the polls; this sets the stage for tax-mimicking behaviour (Sollé-Ollé, 2003).

Assuming local politicians are rational agents, they anticipate voters' yardstick behaviour and take it into account before deciding on their own policies to avoid being perceived by voters as bad politicians and to be voted-out on elections. As a consequence, local politicians take directly into account not only their own jurisdiction's political opponents but also the policy decisions taken in neighbouring jurisdictions, to maximize their chances to remain in power.

In a setting where benevolent, non rent-seeking politicians exist, they will ultimately generate positive informational externalities, which voters can use to punish the selfish and opportunistic politicians at the local elections. Thus, if politicians of the latter type do not engage in tax mimicking, their re-election chances hinder (Besley and Case, 1995; Heyndels and Vuchelen, 1998).

As a result, the yardstick mechanism leads to strategic interactions in the form of mimicking behaviour among politicians, who adapt their decisions to the ones of their neighbours in order to provide a signal to voters on the quality of their performance and, through it, to increase their chances of re-election (Buettner and Schwerin, 2016).

The task of comparing the fiscal performance of nearby jurisdictions will be harder for voters when relevant information is not readily available or when the tax rates differ greatly from one jurisdiction to another (Reulier and Rocaboy, 2009). Indeed, the more complex the institutional framework, the easier it is for rent-seeking politicians to justify tax rate increases without facing electoral consequences.

In a decentralized tax system, the political consequences of tax changes depend on the surrounding circumstances (Besley and Case, 1995). A tax increase can be better tolerated by voters when there are similar increases in neighbouring jurisdictions. Likewise, if voters observe tax cuts in neighbouring jurisdictions, they are less likely to accept their local politician not to lower taxes too. Similarly, the higher the number of geographical neighbours surrounding a jurisdiction, the easier and more effective one can expect this yardstick comparison mechanism to be.

Under yardstick competition, incumbents are more likely to face defeat if they increase taxes, and less likely to lose if their neighbours increase taxes. Thus, electoral defeat is positively correlated with tax increases in each jurisdiction, and negatively correlated with tax increases in neighbouring jurisdictions (Besley and Case, 1995).

Moreover, voters have more difficulty in identifying the politician responsible for a tax change in coalitions, due to a lower “clarity of responsibility” (Solé-Ollé, 2003:686). This makes the yardstick mechanism to be less effective, since local coalition governments are less likely to be held accountable for their economic performance and thus will be less worried with mimicking their neighbours’ tax policies. This effect is called the political fragmentation effect, and it can be measured by the number of parties forming a coalition (Allers and Elhorst, 2005).

Another corollary from the electoral accountability hypothesis is that in jurisdictions where incumbents cannot run for re-election because of institutional binding term limits, one can expect ideological factors to be more dominant in the decision-making process, and mimicking behaviour of neighbouring jurisdictions’ policies tends to be absent (Heyndels and Vuchelen, 1998). Thus, term-limited mayors will tend to set higher tax rates than those of their counterparts (Padovano and Petrarca, 2014). In this case, the yardstick competition hypothesis can be tested by comparing jurisdictions whose politicians are eligible for re-election to those jurisdictions whose politicians are not. If strategic interaction is only found in the former, there is evidence for yardstick



competition. In contrast, under tax competition, mimicking behaviour should occur regardless of re-election opportunities (Allers and Elhorst, 2005).

A third corollary is that expected competition for votes tends to be higher in election years. On the other hand, if strategic interactions are driven by the fear of loss of tax bases, as tax competition predicts, there is little reason to expect interactions to be stronger when electoral accountability is higher (Solé-Ollé, 2003).

In addition to electoral accountability, other determinants also play a role on the effectiveness of yardstick competition. In particular, mimicking behaviour is expected to be less pronounced in jurisdictions governed by mayors elected by a large share of the votes or by coalitions backed by a large share of the city council. One reason for that is that politicians in such a comfortable position are confident of being re-elected, so they enjoy more freedom to set their own tax policies. In other words, mimicking neighbouring is expected to decrease as the electoral margin increases (Allers and Elhorst, 2005). More generally, only incumbent governments that face uncertain electoral outcomes are expected to engage in mimicking behaviour (Bordignon et al., 2003). According to Padovano and Petrarca (2014), the popularity of the incumbent is typically measured by the share of votes obtained in the last election results.

Another prediction under the yardstick competition theory is related to the partisanship effect. Mimicking behaviour is expected to be stronger when right-wing parties are in control, since right-wing voters are generally more sensitive to tax increases in neighbouring jurisdictions than left-wing voters (Allers and Elhorst, 2005). On the other hand, when left-wing parties are in control, mimicking behaviour is expected to be less pronounced, since left-wing parties are expected to be less sensitive to initiatives from neighbouring jurisdictions to reduce taxes (Solé-Ollé, 2003).

### ***Tax and welfare competition***

A third theoretical explanation of strategic interactions is that of tax competition, first discussed in Tiebout (1956) and further developed by Wilson (1986) and Zodrow and Mieszkowski (1986), which arises from mobility-led competition. This explanation of strategic competition is based on the interjurisdictional mobility of the tax base.

The analytical framework for tax competition is based on resource-flow models *a la* Tiebout (1956), under which resource flows between jurisdictions are the source of strategic interaction, thus obviating the case for political competition (Besley and Case, 1995). Under this hypothesis, fiscal interdependence occurs when local jurisdictions decide on their tax rates taking into account its effects on mobile resources.

In Tiebout (1956), individuals (“consumer-voters”) are aware of the differences in tax and expenditure patterns among jurisdictions and they react accordingly by moving to the jurisdiction that best satisfies their preference patterns. In Tiebout (1956)-type models, jurisdictions finance the provision of public goods with a tax on local capital. Local capital is nationally fixed but it is mobile across jurisdictions. The spatial distribution of firms and individuals – mobile tax bases in each jurisdiction – depend both on the jurisdiction’s tax rates and on those of the neighbouring jurisdictions. *Ceteris paribus*, a higher tax on capital in a given jurisdiction would benefit neighbouring jurisdictions with the inflow of mobile factors (Buettner and Schwerin, 2016). Consequentially, each jurisdiction is indirectly affected by the policies of neighbouring jurisdictions, making tax policy decisions interdependent, generating strategic interaction (Revelli, 2002; Geys, 2006). Allers and Elhorst (2005:1) label the option of mobile tax bases to escape tax increases the “exit mechanism”.

If competition for resources is high, one can expect local tax rates to be low, as jurisdictions attempt to keep their tax base. While the literature admits competition to be beneficial for consumers (because it generates a diversity of public-good choices), there is also view (which has since sparked a debate on the merits of decentralization) that follows on the bad side of local competition and strategic behaviour: welfare losses (Case et al., 1993). Low local tax rates set as a result of interjurisdictional competition to attract capital flows could lead to inefficient taxation and to under-provision of public goods as taxes are used to finance them (Brueckner and Saavedra, 2001).

A related literature, which can be seen as a direct extension of the tax competition models, is the welfare competition model. In this fourth explanation of fiscal interdependence across jurisdictions, strategic interaction arises from the interjurisdictional mobility of residents who seek benefits from local state governments’ social welfare redistribution programs (“welfare migration” occurs). In this case, the competitive behaviour of local jurisdictions is more peculiar. Instead of trying to attract

and maintain a mobile tax-base, local politicians' decisions are such that aim at keeping the high income residents and repel the social welfare recipients (Saavedra, 2000).

In both tax and welfare competition models, firms and individuals are expected to choose to locate in the jurisdiction that offers them the best combination of the expenditure-revenue bundle (Heyndels and Vuchelen, 1998).

## **1.2. Overview of empirical studies**

The empirical literature on strategic horizontal interactions among local governments has been rapidly expanding, to a large extent because of recent developments both theoretically and in spatial econometrics. Table 1 provides an overview of empirical studies. Most empirical studies on the revenue side analyse taxes where strategic interaction is more likely to occur (business tax and income tax). A significant number of these studies also test the yardstick hypothesis. In general, as stated in Gérard et al. (2010) and Buettner and Schwerin (2016), the empirical literature finds evidence of strategic interactions between local governments.

Of the selected 27 papers, only Lyytikäinen (2012) and Baskaran (2014) found no evidence of interactions in tax rates. Both these papers use non-traditional regressions. Lyytikäinen (2012) uses a Quasi-experimental design, while Baskaran (2014) uses the Difference in Difference and the Spatial Lag framework with unconventional instruments. These authors suggest the traditional literature may be overestimating the degree of interdependence in tax rates.

Regarding empirical evidence for Portugal, and to the best of our knowledge, three papers have tested for fiscal strategic interactions on the revenue side – Coimbra et al. (2011), Costa et al. (2011) and Costa and Carvalho (2013) –, and three other on the expenditure side – Barreira (2010), Barreira (2011) and Costa et al. (2015). Coimbra et al. (2011) and Costa et al. (2011) assessed the existence of fiscal strategic interactions for the variable participation rate in the Personal Income Tax. In both papers, the empirical results for this tax rate were unstable and partially inconclusive. The authors believe the results may have been influenced by the small amplitude of the rate variable and because,

in 2009 (both studies use cross-sectional data for that year), strategic interactions concerning this tax rate were still unlikely to have emerged.<sup>1</sup>

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<sup>1</sup> As explained in section 2.3., the participation rate in the Personal Income Tax varies from 0% to 5%. In 2008, municipalities were able to set their participation rate using this 5% margin. In 2009, 127 municipalities (over 40% of the 308 municipalities) did not actively choose a tax rate; thus their tax rate was set to 0% by Law to benefit the local taxpayers, further limiting the observed variability of the rate.

**Table 1**  
Overview of empirical studies

Authors	Spatial dimension		Time period	Fiscal tool	Evidence of strategic interaction	Source of strategic interaction
	Country	Territorial unit				
Besley and Case (1995)	United States of America	Continental States	1960–1988	Effective income-tax liabilities	Yes	Yardstick competition
Heyndels and Vuchelen (1998)	Belgium	Municipalities	1991	Income tax and property tax	Yes	—
Saavedra (2000)	United States of America	States	1985, 1990, 1995	Benefit support program	Yes	Welfare competition
Brueckner and Saavedra (2001)	United States of America	Cities in the Boston metropolitan area	1980, 1990	Property tax	Yes	Tax competition
Buettner (2001)	Germany	Municipalities in the state of Baden-Württemberg	1981–1996	Business tax	Yes	Tax competition
Revelli (2002)	England	Non-metropolitan districts	1990	Public expenditure per capita and property tax	Yes	—
Schaltegger and Küttel (2002)	Switzerland	Cantons	1980–1998	Fiscal autonomy and legislation	Yes	Yardstick competition
Bordignon et al. (2003)	Italy	Municipalities in the Province of Milan	2000	Property tax	Yes	Yardstick competition
Soké-Oké (2003)	Spain	Municipalities	1992–1999	Property tax, vehicle tax and business tax	Yes	Yardstick competition
Allers and Elhorst (2005)	Netherlands	Municipalities	2002	Property tax	Yes	Yardstick competition
Geys (2006)	Belgium	Municipalities of the Flemish Region	2000	Efficiency ratings	Yes	—
Elhorst and Fréret (2009)	France	Mainland departments	1992–2000	Welfare spending	Yes	Yardstick competition
Reulier and Rocaboy (2009)	France	Regions	1986–1999	Property tax, housing tax and business tax	Yes	Yardstick competition [property tax] and tax competition [business tax]
Barreira (2010)	Portugal	Municipalities of the Northern Region	1998–2008	Public expenditure per capita	Yes	Expenditure spillovers
Gérard et al. (2010)	Belgium	Municipalities	1985–2004	Surcharges on income tax and property tax	Yes [surcharge on labour income tax]	—
Barreira (2011)	Portugal	Municipalities of the Southern Region of Algarve	1998–2007	Public expenditure per capita	Yes	Expenditure spillovers
Delgado and Mayor (2011)	Spain	Municipalities in Asturias	2004	Property tax, motor vehicle tax and building activities tax	Yes [property tax and building activities tax]	—
Coimbra et al. (2011)	Portugal	Mainland municipalities	2000–2009	Property tax, surcharge on business tax, participation in income tax	Yes	—
Costa et al. (2011)	Portugal	Mainland municipalities	2000–2009	Property tax, surcharge on business tax, participation in income tax	Yes	Yardstick competition [Property tax and surcharge on business tax]
Lyytikäinen (2012)	Finland	Municipalities	1993–2004	Property tax	No	—
Costa and Carvalho (2013)	Portugal	Mainland municipalities	2003–2011	Property tax	Yes	Yardstick competition
Makderen and Gérard (2013)	Belgium	Municipalities of the Walloon Region	2012	Surcharges on income tax and property tax	Yes	—
Sedmlířská (2013)	Czech Republic	Municipalities	2009–2013	Property tax	Yes	Yardstick competition
Baskaran (2014)	Germany	Municipalities in the state of North Rhine-Westphalia	2003	Property tax and business tax	No	—
Padovano and Petrarca (2014)	Italy	Municipalities	1995–2004	Property tax	Yes	Yardstick competition
Costa et al. (2015)	Portugal	Mainland municipalities	1986–2006	Expenditure levels per capita	Yes	Expenditure spillovers and tax competition
Buettner and Schwerin (2016)	Germany	Municipalities in the state of Baden-Württemberg	2011	Business tax	Yes	Yardstick competition

Source: Own research.

## **Chapter 2. Portuguese local institutional framework**

With the intent of exploring strategic interactions among decentralized government units in Portugal, this chapter provides features of the institutional framework that characterize those units, namely those relevant for enabling financial autonomy to choose revenue and expenditure levels.

In Portugal, there are two sublevels of government at the local level: municipalities (“municípios”) and civil parishes (“freguesias”).

The local government unit we will focus on is the municipality. That is because Portuguese municipalities are the most important and the highest-level local authorities, both in political and financial power. Being closer to the population than central authority, they are responsible for improving the well-being of the residents in their jurisdictions. In particular, municipalities promote social and economic development, improve the territorial organization (urban and local planning) and supply a wide range of local public goods and services (such as water and sewage, transportation, housing, healthcare, education, culture, sports, environmental protection and civil protection assistance) (Baleiras, 1997; Veiga, 2003; Veiga and Pinho, 2007; Castro and Martins, 2013). The budgeting rules, competences and policy instruments are the same for all Portuguese mainland municipalities regardless of their size (Veiga, 2003; Veiga and Veiga, 2007; Barreira, 2011).

Civil parishes (“freguesias”), on the other hand, are the lowest administrative unit in Portugal. They have a very limited scope of competencies, performing tasks delegated from their respective municipalities (Jorge et al., 2006; Costa et al., 2015).

In Portugal there are currently 308 municipalities (278 in mainland and 30 in the islands of Madeira and Azores) and 3092 civil parishes.

### **2.1. Decentralization path in Portugal**

After a 48-year period of dictatorship, with the revolution of April 25, 1974, democracy was re-established in Portugal.

The Portuguese Constitution of 1976 introduced major changes to local governments, including administrative decentralization, local autonomy and own property and financing for local authorities (Teixeira et al., 2015).

Since then, over the last 40 years, there has been a total of six Local Finance Laws approved, each of which set in motion a process of progressive decentralization of competencies from the central government to local authorities in order to generate a more efficient allocation of resources (Costa et al., 2015; Martins and Veiga, 2013).

In particular, municipalities have benefited from a higher autonomy, more discretionary power and more resources, which has translated into an increasing role in the areas of economic policy and in the provision of local public goods and services (Pinho and Veiga, 2005; Coimbra et al., 2011).

In the last few years, fiscal decentralization has been at the centre of the Portuguese policy agenda. Decentralization is believed to improve governance (by increasing local responsiveness), allocative efficiency and political participation and accountability (Sedmihradská, 2013). Structural reforms to increase decentralization in the recent context of the 2011–2014 international financial assistance programme to Portugal have resulted in changes in the distribution of powers and responsibilities of municipalities.

In particular, with the previous and current Local Finance Laws (the Law 2/2007, January 15<sup>th</sup>, and the current Law 73/2013, September 3<sup>rd</sup>), legislative changes and new measures were approved aimed at increasing the fiscal competences of municipalities in the revenue side; promoting financial autonomy, inter-municipal fiscal competition and electoral accountability, as well as cost reductions and transparency in municipal management as a way to foster local development (Costa, 2011; Veiga et al., 2015). On February 16<sup>th</sup>, 2017, a law proposal (Law Proposal 62/XIII) has been presented by the government to the parliament with the objective of transferring yet more central powers to local powers, particularly in the case of the Municipal Tax on Real Property (“IMI”), to further strengthen these goals. It has not yet been approved by the parliament.

These consecutive and still ongoing decentralisation reforms have been put into place with the belief that, despite the current financial difficulties, local politicians and local voters have reached a stage of democratic maturity and are now more concerned with sustainability, quality of management, transparency and political accountability

(Coimbra et al., 2011; and Costa, 2011). These new challenges facing municipalities require them to formulate strategic decisions in terms of financial management. The current new environment has led to a higher perception of growing competition among municipalities, especially on the revenue side, where local fiscal competences have been increased (Costa and Lança, 2013). This has made policies to reduce the residents' fiscal burden more appealing than before (Costa, 2011).

It is worthwhile to point out that fiscal spatial interaction is still a very recent phenomenon in Portugal, because fiscal instruments in the past have never been relevant enough to spark spatial interactions, especially on the revenue side. Historically, local competition was mainly driven by the expenditure side, which is now relatively less importance because most of the needs on local infrastructure are already satisfied (Costa et al., 2011; Costa and Carvalho, 2013).

Furthermore, with the decentralization reforms and the maturing of democracy, voters have become more sophisticated and their scrutiny is likely to increase on the revenue side, since they have easy access to readily available relevant information on the tax rates municipalities set. This allows voters to use such information to evaluate and hold their local politicians accountable (voters use taxes as the best indicator of relative competency because other types of output/performance indicators at the municipal level practically do not exist in Portugal) (Veiga and Veiga, 2007; Costa et al., 2015).

## **2.2. Fiscal competences of Portuguese municipalities**

The Portuguese Constitution endows municipalities with financial autonomy. However, they are subject to several control mechanisms put in place by the central government, which limit their access to revenues and expenditure choices (Veiga, 2003).

Municipalities rely on unconditional transfers, both from the central government and the European Union, and on own fiscal revenues as main sources of municipal revenue (Veiga, 2003; Coimbra et al., 2011). The transfers have a redistributive nature. They aim to address both vertical and horizontal imbalances (the importance of transfers in the total municipal revenue is negatively related with the level of development of each municipality) (Coimbra et al., 2011; Costa and Carvalho, 2013).



Municipal taxes are collected by the central government and then returned to the municipality as fiscal revenue. Municipalities have some discretionary power to modify the rates of these taxes (Jorge et al., 2006). Municipal taxes are the following: the variable participation in the Personal Income Tax (“participação variável no IRS”), Municipal Tax on Real Property (“IMI”), Municipal Tax on Real Estate Transfer (“IMT”), a surcharge on Corporate Income Tax (“Derrama”) and the Tax on Vehicle Circulation (“IUC”) (Costa and Carvalho, 2013; Teixeira et al., 2015).

Despite the mentioned decentralization, the fiscal autonomy of Portuguese municipalities is still relatively low (Costa, 2006). On average, in 2015, municipal taxes accounted for 37.9% of total revenues of Portuguese municipalities, while transfers accounted for 41.1%, according to numbers taken from the management accounts of the Portuguese Directorate-General for Local Authorities. However, if we compare the current average fiscal autonomy levels to those of 1986 (18% of total revenues for municipal taxes and 63% of total revenues for transfers), the data suggest that the discretionary power on the revenue side has been increasing as a reflection of the decentralization policies taken in Portugal (Costa et al., 2015).

Regardless of recent improvements, transfers from the central government continue to be the most important source of municipal funding. This dependence on intergovernmental transfers can be demonstrated by the fact that in about half of the Portuguese municipalities (most of them located in the inner Portuguese mainland) own-levied tax revenues historically account for less than 25% of total revenue. This is because many municipalities have very low tax bases; smaller municipalities are very sparsely populated (about 35% of municipalities have less than 10 000 residents) and lack meaningful economic activity (Costa, 2011; Costa and Carvalho, 2013).

### **2.3. The variable participation rate in the Personal Income Tax**

The Local Finance Law of 2007 provided municipalities with the ability to participate in a percentage of the revenue collected from the Personal Income Tax (“IRS”) (the law took effect on January 15<sup>th</sup>, 2007). The current Local Finance Law (Law 73/2013 of September 3<sup>rd</sup>) maintained this new responsibility (articles 25 and 26) and added new

requirements on local accountability and on the provision of information to local voters (Costa and Lança, 2013; Teixeira et al., 2015).

As a result, since 2007, Portuguese municipalities are entitled to 5% of the Personal Income Tax collected by the central government over the taxpayers who are resident in the municipality. Municipalities are able to decide, on a yearly basis, on what to do with this tax revenue: whether to keep it as revenue or to return it, in part or totally, to the benefit of their local taxpayers. This new competence is called the variable participation rate in the Personal Income Tax. A 5% participation rate (maximum rate) means that the municipality keeps all the income tax revenue it is entitled to. By setting a participation rate below 5%, the municipality is deciding to give a percentage of the income tax that is part of its tax revenue to its taxpayers. Taxpayers will also benefit if the municipality does not actively decide on the participation rate (this happens when a municipality fails to communicate its desired variable participation tax rate to the tax authority); in this case, the rate is set to 0% (minimum rate) by default, with the 5% of the tax collection reverting in favour of the local taxpayers.

This new municipal fiscal tool was adopted with the goal of increasing decentralization and local autonomy. Portuguese policy-makers were positive that this new tool could lead to a reduction of public expenditure while, at the same time, making municipalities less dependent on the revenues from central government's transfers. That is because, since municipalities are now able to decide the percentage of the income tax revenue they receive up to the 5% threshold, policy-makers predict an increase in inter-municipal fiscal competition and in local political accountability for financial decisions (Teixeira et al., 2015).

There still exists a considerable margin for municipalities to increase their variable participation rate in income tax by adopting higher tax rates (e.g., in 2015, municipalities chose not to receive a combined amount of 54.7 million euros) (Veiga et al., 2015). Table 2 shows the number of municipalities according to different participation rates of the "IRS". The number of municipalities actively deciding on the variable participation rate has been growing, especially in the last three years: in the first seven years, on average, 196 municipalities (63.7%) have actively decided their participation rate; this number has risen to an average of 304 municipalities (98.6%) in the last three

years (shown in the second to last column of Table 2). This is a good indicator of an increased perception of higher fiscal competition in recent years.

**Table 2**

Number of municipalities according to the IRS variable participation rate (2008–2017)

Year	Maximum rate (5%)	Between maximum rate and minimum rate	Minimum rate (0%)	Minimum rate (0%) by default	Below maximum rate	Actively deciding on the rate	Total
2008	143	35	9	121	165	187	308
<b>2009</b>	117	50	14	127	191	181	308
2010	122	56	10	120	186	188	308
2011	138	43	8	119	170	189	308
2012	156	36	7	109	152	199	308
<b>2013</b>	132	58	14	104	176	204	308
2014	148	65	13	82	160	226	308
2015	188	97	19	4	120	304	308
2016	202	86	18	2	106	306	308
<b>2017</b>	188	94	19	7	120	301	308

Source: Portuguese Tax Authority. Own calculations.

The number of municipalities deciding on a variable participation rate under 5% (shown in column 6, “Below maximum rate”, in Table 2) – the municipalities that give up a percentage of the income tax they are entitled to in favour of their residents –, as well as the number of municipalities deciding to decrease their rates (given by the column “Changed tax rate decreased” in Table 3) tend to be higher in periods of local election (2009, 2013 and 2017, in bold in Tables 2 and 3), and lower in the years following the election periods.

**Table 3**

Number of municipalities according to changes in the IRS variable participation rate (2009–2017)

Year	Same tax rate	Changed tax rate			Total
		Total	Increased	Decreased	
<b>2009</b>	227	81	30	51	308
2010	247	61	35	26	308
2011	253	55	36	19	308
2012	262	46	33	13	308
<b>2013</b>	244	64	22	42	308
2014	236	72	42	30	308
2015	202	106	86	20	308
2016	276	32	8	24	308
<b>2017</b>	267	41	4	37	308

Source: Portuguese Tax Authority. Own calculations.

These are indications that electoral process considerations may be influencing local politicians when they set the participation rate in Personal Income Tax revenues. It is also worth noting that some municipalities which set the participation rate very low (even to 0%) are dealing with unbalanced financial situations (Veiga et al., 2015).

Since it is our goal to test whether fiscal interactions among municipalities occur – whether decisions on the participation rate in the Personal Income Tax of a municipality take into consideration the participation rates of neighbouring municipalities – and (if there is evidence of such interactions) whether they are, in the context of yardstick competition, shaped by political competition and accountability, the current environment lends additional relevance to our study.

Table 4 provides the descriptive statistics for the variable participation rate in IRS for the period 2008–2017. The average rate value is 0.0317. The standard deviation values indicate that the observed values of the rate are substantially close to the average value. The small variation of the observed values around the average value is conditioned in part by the values being limited to the 0 to 5% rate margin.

**Table 4**  
Statistics for the variable participation rate (2008–2017)

Min			Max			Mean	SD		
Within	Between	Overall	Within	Between	Overall		Within	Between	Overall
-0.0133154	0	0	0.0766846	0.05	0.05	0.0316846	0.0166265	0.0145605	0.0220869

Source: Portuguese Tax Authority. Stata computations.

## 2.4. Portuguese local elections

Each municipality has a City Council and a Municipal Assembly as their representative branches. The City Council has the executive power (it elaborates and implements local policies), whereas the Municipal Assembly is a deliberative body (it approves the overall framework of local policies) (Martins and Veiga, 2013).

The members of the City Council and half of the Municipal Assembly are directly elected by the voters registered in the municipality. The other half of the Municipal Assembly is reserved to the council presidents of the civil parishes located in that municipality (Veiga and Veiga, 2007). On local election day, residents vote for parties or independent lists presented for both local branches (local elections take place in the same

day for every jurisdiction in Portugal). The outcome is determined by the D'Hondt method of transforming votes into mandates (Castro and Martins, 2013). The mayor of the municipality, who has a key role in the executive, is the first candidate from the list who gathers the larger amount of votes in the municipal elections for the City Council.

Since the re-establishment of Democracy in 1974, local elections took place in 1976, 1979, 1982, 1985, 1989, 1993, 1997, 2001, 2005, 2009 and in 2013. The current year, 2017, is also a local election year.

Until the municipal elections of 2005, mayors did not have any legal limit on the number of previous terms in office. This changed with the Law 46/2005 of August 29<sup>th</sup>, which imposed a three four-year term limit restriction to every municipal office-holder.

## **2.5. Assessing strategic interaction in local public finances in Portugal**

On a theoretical basis, strategic interactions are expected to be stronger on taxes levied on resources that are more mobile (e.g., Municipal Corporate Tax) or where electoral perception is stronger (e.g., Personal Income Tax) (Coimbra et al., 2011).

The aim of our study is to assess the strategic interactions in local public finances in Portugal through the variable participation rate of the Personal Income Tax. As explained above, this strategic variable relies on the ability municipalities have to either return up to a maximum of 5% of the Personal Income Tax ("IRS") to their residents or keep that amount as tax revenue. The ability to decide on returning a percentage of the income tax collected is still a very recent addition to the fiscal tools of the Portuguese municipalities, which can be seen as part of the ongoing trend of fiscal decentralization that has been happening in several European countries. Thus, understanding if strategic interaction is a real phenomenon is not only of academic interest, but can also help design a better institutional framework.

Because of the framework concerning the tax rates in our study – considering the homogenous institutional setting (which makes comparisons across municipalities more easy and clear), together with the increasing degree of tax transparency, local community engagement and fiscal decentralization, as well as the high visibility nature of the income tax –, we expect an increasing encouragement not only for local politicians to engage in more tax interactions but also for local voters to intensify comparisons across

jurisdictions that may ultimately hold opportunist politicians responsible by voters punishing bad performances.

Indeed, the extent to which “resource-flow” models can accurately explain strategic interactions has been subject to much debate. According to Besley and Case (1995), it is reasonable to say that resource flows can only be a long-run solution to differences in the tax rates among jurisdictions. In the short-run, the ballot box can serve an important purpose which, even the long-run, gives citizens a less costly alternative to the “exit mechanism”.

In fact, while the “exit” possibility in a fiscally autonomous jurisdiction allows for inter-jurisdictional mobility – a necessary condition for local tax competition –, in principle, the transaction costs of moving from one jurisdiction to another are potentially higher for residents than they are for firms. Because of that, mobility of voters is likely not as high as that of firms. This leaves some leeway for bad politicians’ tax policies to act out of line in what concerns their citizens’ preferences. It is also worthwhile pointing out that the models of local strategic interactions based on tax competition typically assume that voters are immobile (Reulier and Rocaboy, 2009).

The yardstick competition hypothesis, on the other hand, puts the emphasis on the importance of the “voice mechanism”. Voice, in the sense of democratic rights, can be seen as a powerful instrument, a substitute for the “exit mechanism” (Schaltegger and Küttel, 2002), especially in a direct democratic institutional framework where voters make themselves heard by their voting power – the power to elect their desired local politicians.

We believe that the 5% maximum tax margin in the variable participation in the Personal Income Tax, as important as it may be to sparkle strategic interaction (because of the very visible nature of the income tax), is not large enough to trigger significant inter-jurisdictional migratory movements. Therefore, tax and welfare competition are unlikely to be the drivers of strategic interaction resulting from the municipal participation in the Personal Income Tax.

Likewise, expenditure spillovers are also not likely to be the driver of strategic interaction, since the 5% maximum tax margin in the participation of municipalities in the tax revenue does not have an impact in the financing of local expenditures large enough to trigger a spillover effect.

Thus, *a priori*, yardstick competition seems to have the most potential explanatory power in the case of our strategic variable for the assessment of strategic interaction among Portuguese municipalities. The yardstick comparison mechanism can give us powerful insights on the structure of local governments, especially in a context of decentralization and local government reforms (Bordignon et al., 2003). In fact, it may be the case that the pessimism regarding decentralized taxation may not be fully justified (Buettner and Schwerin, 2016). This is because yardstick competition helps to prevent bad politicians from extracting rents, making local governments more accountable by forcing them to align to efficient policies (Padovano and Petrarca, 2014), especially in electoral years.

## Chapter 3. Empirical framework

In this chapter, we present a summary of the standard methodology used to assess horizontal spatial strategic interactions in local public finances. This includes the presentation of the general form of the empirical reaction function which captures possible strategic interaction effects, of the criteria for the definition of neighbourhood (on which the spatial weights matrix is based), and of how to overcome the econometric issues that typically arise when estimating the reaction functions.

Our study deals with spatial panel data models. We discuss the use of panel data, the spatial panel models to be estimated, and the estimation strategy method – the Quasi-Maximum Likelihood (QML) method.

### 3.1. Empirical model

Methodologically, choosing between the two types of strategic interaction models – the spillover and the resource-flow models – poses a problem because, despite their differences, the reduced-form spatial reaction function is similar in both types of models (Brueckner, 2003). In particular, yardstick competition and tax/welfare competition models can generate a similar empirical framework, which would make empirical evidence observationally equivalent and consistent with competing theories of local strategic interaction that have different normative implications (Brueckner and Saavedra, 2001; Bordignon et al., 2003).

In general, the reaction function relates each jurisdiction's strategic decision variable,  $y_i$ , to the jurisdiction's own characteristics,  $X_i$ , and to the choices of  $n_i$  reference neighbouring jurisdictions relative to the same strategic variable,  $y_j$ . The equation to be estimated is, usually, of the following form (Brueckner, 2003):

$$y_i = \beta \sum_{j \neq i}^{n_i} W_{ij} y_j + X_i \theta + \varepsilon_i \quad (1)$$

where  $\beta$  and  $\theta$  represent unknown parameters,  $W_{ij}$  is the neighbourhood weights matrix, and  $\varepsilon_i$  is an error term.



To distinguish between the drivers of strategic interactions, it is common to compare a baseline spillover model with one including, in addition, political variables as explanatory variables. If the latter improves the empirical likelihood of strategic interactions, there is evidence for yardstick competition. That is because the yardstick competition model assumes the behaviour of politicians is crucially dominated by electoral considerations, especially in the short-run (Heyndels and Vuchelen, 1998).

According to Elhorst and Fréret (2009), there are two main approaches to identify yardstick competition. One approach is to conclude that if interactions among politicians who significantly react to tax rate changes in neighbouring jurisdictions are significantly greater than those who do not, yardstick competition is present. The other approach follows the reasoning of Bordignon et al. (2003: 200): the “tax setting behaviour and the features of the electoral system should be considered at once in the empirical analysis”. Hence, this approach evaluates the impact of tax rates changes on the election results to test, for instance, whether spatial interaction dependence patterns are different in municipalities governed by an absolute or a simple majority (Costa and Carvalho, 2013).

More recently, another method to test the yardstick competition theory has been proposed. In this line of research, the seminal hypothesis of yardstick competition is tested directly: whether voters punish incumbents for higher tax rates, and whether that punishment depends on the tax rates in neighbouring jurisdictions. This method is called yardstick voting, and it is tested by estimating a popularity/voting function of incumbents (Malderen and Gérard, 2013).

Whatever the approach, if strategic interaction is driven by factors outside the political process, as tax competition predicts, the spatial correlation of tax rates should not differ with or without the inclusion of political variables. This implies that if tax mimicking is shown to be related with the political process, we are in the presence of yardstick competition, since it links spatial interactions with voting behaviour (Sedmihradská, 2013), and we can rule out tax competition as the driver for strategic interaction (Allers and Elhorst, 2005). In this study, considering the estimation results presented in Chapter 4, we do not attempt to test for yardstick competition.

### 3.2. Definition of neighbouring jurisdictions

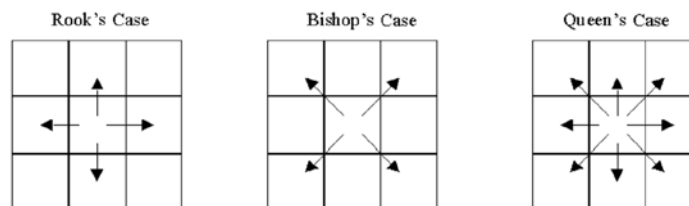
The definition of the criteria of neighbourhood, under which interaction between jurisdictions can be detected, is crucial for the empirical application. The definition of neighbours takes the analytical form of a spatial weights matrix,  $W_{ij}$ , with non-negative weights. The spatial weighing matrix assigns the jurisdictions of reference and their relative weights (Heyndels and Vuchelen, 1998).

These weights define the importance of the other  $j$  jurisdictions in the process of interaction (they dictate whether a given jurisdiction  $j$  and jurisdiction  $i$  interact), and they can be seen as part of jurisdiction  $i$ 's characteristics.

We propose to follow the most commonly used approach that designs the weights matrix according to spatial geographical proximity criteria (see, among others, Ladd, 1992; Besley and Case, 1995; Heyndels and Vuchelen, 1998; and Revelli, 2002). The geographical proximity criteria sets the jurisdictions of reference as the neighbours that share physical borders with one another, and these are weighted equally based on contiguity.

In our study, the spatial weights matrix will be in Queen contiguity form (of the order 1 type). Queen contiguity is one of the three types of polygon contiguity. Under Rook contiguity, neighbour relationships occur between municipalities that share common edges. Under Bishop contiguity, neighbour relationships occur between municipalities that share common corners. Finally, under Queen contiguity, neighbour relationships occur between municipalities that share common geographical borders, regardless of boundary length (be it edges or corners). Figure 1 represents the three types of polygon contiguity.

**Figure 1**  
Types of polygon contiguity



Source: <http://www.lpc.uottawa.ca/publications/moransi/moran.htm> (adapted).

Accessed on 05.07.2017.

The underlying assumption for spatial interaction is that the higher the spatial proximity between municipalities, the higher the degree of interaction is expected to be. In practice, a given element of the  $W_{ij}$  matrix,  $\omega_{ij}$ , has a positive value for jurisdictions  $j$  that share a border with  $i$ , while  $W_{ij} = 0$  is set for non-contiguous jurisdictions. In other words, if a jurisdiction  $i$  shares a border with  $n_i$  jurisdictions, all its neighbours are weighted  $1/n_i$  and the remaining jurisdictions are weighted 0. As to exclude self-neighbours, the diagonal elements  $\omega_{ii}$  are set equal to 0 (Belotti et al., 2017).

The weights matrix is thus row-normalized so that each row sum equals unity for each  $i$ ; the resulting aggregate strategic variable set by neighbours is computed as a weighted average across reference jurisdictions (Brueckner, 2003; Lyytikäinen, 2012),  $\sum_{j \neq i}^{n_i} W_{ij} y_j$ , in equation (1) above.

This approach helps detecting tax mimicking since this is more feasible to arise among jurisdictions that share basic common characteristics, such as sharing the same geographic location (Buettnner and Schwerin, 2016). However, there is also motivation for the use of alternative weighting approaches based on other similar features of jurisdictions (e.g., weighting matrices based on socio-economic distance or on demographic distances). For a broad discussion of alternative ways to measure neighbourhood, see Costa et al. (2015).

### 3.3. Econometric issues

According to the empirical literature, the estimation of the reaction function (1) poses three important spatial econometric issues which must be successfully addressed in order to produce reliable estimates: (i) endogeneity of the strategic variables of other jurisdictions; (ii) possible spatial error dependence; and (iii) possible correlation between each jurisdiction's characteristics ( $X_i$ ) and the error term ( $\varepsilon_i$ ).

In the presence of endogeneity (i), ordinary least squares (OLS) estimates reveal to be inconsistent and inappropriate for models that incorporate spatial effects, thus requiring the use of an alternative estimation method capable of overcoming the deficiencies of the OLS estimator: through Maximum Likelihood (ML), Quasi-Maximum Likelihood (QML), Instrumental Variables (IV), or Generalized Method of Moments

(GMM) techniques (Elhorst and Fréret, 2009; Anselin, 2010; Soro et al., 2016). Another alternative is to assume interaction occurs with a time lag, thus eliminating simultaneity, which makes OLS estimation consistent (Brueckner, 2003).

Spatial error dependence (ii) arises through spatial autocorrelation of omitted variables. It occurs when  $\varepsilon$  is capturing omitted variables that are, themselves, spatially dependent. If such dependence is ignored, results of strategic interaction can be misleading. To deal with this problem, one approach is to use the ML method either taking into account the error structure, or assuming the absence of spatial error dependence (relying on hypothesis tests to verify these assumptions). Another approach is to rely on the IV estimation method (Brueckner, 2003).

When the jurisdiction's characteristics are correlated with the error term, both the ML and IV estimates are inconsistent. To correct this problem, one must find suitable instruments for the dependent variables, which can be a difficult task. An alternative approach is to use panel data, since estimation captures time-invariant jurisdictional characteristics, observed or unobserved, through jurisdiction's specific intercepts. The use of panel data may also help to eliminate spatial error dependence (Brueckner, 2003).

### **3.4. Spatial Panel Data models**

The spatial econometrics literature presents a panoply of models, which can be used empirically as a tool to detect and measure spatial interaction effects. These interaction effects are crucially assumed to decrease as distance between the spatial units increases (Belotti et al., 2017).

While traditionally these models have been estimated with the use of cross-sectional data, in more recent years, with the increasing availability of data sets, there has been a shift to using panel data in order to assess spatial interactions across spatial units and over time (Millo and Piras, 2012).

The increasing use of panel data sets has come hand in hand with a growing interest in panel spatial econometrics, which has caused the development of estimation techniques for spatial panel models (Elhorst, 2013; Soro et al., 2016). Indeed, the use of panel data offers researchers “extended modelling possibilities as compared to the single equation cross-sectional setting” (Elhorst, 2014: 389), and enables “researches to take

into account the dynamics and control for the unobservable heterogeneity” (Lee and Yu, 2010: 165). Specifically, models of tax mimicking using spatial panel data allow for non-observed fixed local characteristics to be controlled for (Allers and Elhorst, 2005). Moreover, “panel data are generally more informative, and they contain more variation and less collinearity among the variables. The use of panel data results in a greater availability of degrees of freedom, and hence increases efficiency in the estimation. Panel data also allows for the specification of more complicated behavioural hypotheses, including effects that cannot be addressed using pure cross-sectional data” (Elhorst, 2013: 6).

In this study, we use the Stata software to estimate the following spatial panel data models, using strongly balanced panel data: the Spatial Autoregressive Model (SAR); the Spatial Error Model (SEM); the Spatial Autocorrelation Model (SAC); the Spatial Durbin Model (SDM) and the Generalized Spatial Random-Effects Model (GSPRE).

From the various estimation methods we have alluded to in the previous section (3.2.), all the models estimated in this study fall into the Quasi-Maximum Likelihood (QML) method. It is recognized that “the ML and QML methods are so far the most appropriate methods to fit spatial panels” (Soro et al., 2016: 2).

In the aforementioned models, each period is given by  $t = 1 \dots, T$ ;  $y_t$  is the  $n \times T$   $\times 1$  column vector of the dependent variable;  $X_t$  is the  $n \times k$  matrix of regressors;  $W$  is the  $n \times n$  matrix, which describes the spatial arrangement of the  $n$  units; and  $W_{ij}$  represents the spatial weight associated to units  $i$  and  $j$  (Belotti et al., 2017).

### ***Spatial Autoregressive Model (SAR)***

The Spatial Autoregressive Model (SAR) postulates endogenous interaction effects among the dependent variable (known as spatial lag – because the dependent variable is spatially lagged) (Soro et al., 2016).

In this model, a municipality’s tax rate depends on a series of observed local characteristics and on neighbouring municipalities’ tax rates (Bordignon et al., 2003; Allers and Elhorst, 2005).

The SAR model structure can be represented as:

$$y_t = \rho W y_t + X_t \beta + \mu + \epsilon_t \quad t = 1 \dots, T \quad (2)$$

Where  $\mu$  is a vector of parameters to be estimated for the fixed-effects variant.

It is assumed that  $\varepsilon_{it} \sim N(0, \sigma_\varepsilon^2)$  and  $E(\varepsilon_{it} \varepsilon_{js}) = 0$  for  $i \neq j$  and/or  $t \neq s$  (Belotti et al., 2017).

### ***Spatial Error Model (SEM)***

The Spatial Error Model focuses on spatial autocorrelation across space in the error terms (known as error lag – because it incorporates a spatially autoregressive process in the error term) (Soro et al., 2016; Belotti et al., 2017).

In this model, a municipality's tax rate depends on a series of observed local characteristics (which typically include structural characteristics of the jurisdiction; socio-demographic characteristics of the resident population; fiscal variables; and – in particular when testing the yardstick competition hypothesis – political variables) (Bordignon et al., 2003; Allers and Elhorst, 2005).

The SEM model structure can be represented as:

$$y_t = X_t \beta + \mu + v_t \quad (3)$$

$$v_t = \lambda M v_t + \varepsilon_t \quad (4)$$

The Spatial Error Model can be shown to be a special case of both the Spatial Autocorrelation Model and the Spatial Durbin Model (Belotti et al., 2017).

### ***Spatial Autocorrelation Model (SAC)***

The Spatial Autocorrelation Model postulates a combination of both the interaction among the dependent variable and the interaction among the error terms. This model is also referred to as the spatial autoregressive with spatially autocorrelated errors (SARAR). It combines the Spatial Autoregressive Model with autoregressive disturbances (a spatial autoregressive error) (Soro et al., 2016; Belotti et al., 2017).

The SAC model structure can be represented as:

$$y_t = \rho W y_t + X_t \beta + \mu + v_t \quad (5)$$

$$v_t = \lambda M v_t + \varepsilon_t \quad (4)$$

Where  $M$  is a spatial weights matrix that may or not be equal to  $W$  (they are equal in our study) (Belotti et al., 2017).

### ***Spatial Durbin Model (SDM)***

The Spatial Durbin Model (SDM) is a generalization of the Spatial Autoregressive Model in which spatially lagged independent variables are also included as explanatory variables (Elhorst, 2014; Belotti et al., 2017).

The SDM model structure can be represented as (Belotti et al., 2017):

$$y_t = \rho W y_t + X_t \beta + W Z_t \theta + \mu + \epsilon_t \quad (6)$$

### ***Generalized Spatial Random-Effects Model (GSPRE)***

The Generalized Spatial Random-Effects Model (GSPRE) is a generalization of the Spatial Error Model in which the  $\mu$  (a vector of parameters representing the panel effects) is spatially correlated (Belotti et al., 2017).

The GSPRE model structure can be represented as:

$$y_t = X_t \beta + \mu + v_t \quad (3)$$

$$v_t = \lambda M v_t + \epsilon_t \quad (4)$$

$$\mu = \Phi W \mu + n \quad (7)$$

Where the vectors  $\mu$  and  $\epsilon_t$  are assumed as independently normally-distributed errors, which implies a random-effects variant, with  $\mu = (I - \Phi W)^{-1} n$  and  $v_t = (I - \lambda W)^{-1} \epsilon_t$  (Belotti et al., 2017).

## Chapter 4. Empirical results

In this chapter we present the results of our research. It includes a preliminary spatial-dependence analysis: firstly, we explore the Moran's I and Local Indicators of Spatial Association (LISA) statistics to see whether there is evidence of spatial effects and spatial clustering for our dependent variable – the municipalities' variable participation rate of the Personal Income Tax (VPR). To test whether the detected neighbourhood effects can be attributed to strategic interactions between Portuguese municipalities, we estimate five spatial panel models, using panel data for the period 2008–2015. These models are able to incorporate the spatial dependence through the spatial weights matrix.

We first present a preliminary spatial-dependence analysis, the data and descriptive statistics for the interjurisdictional, fiscal and socio-demographic variables used in the study. Then, we analyse the empirical results obtained from the estimation of the spatial panel models.

### 4.1. Preliminary spatial analysis

In order to have a preliminary idea about the dynamics of the spatial dependence of our dependent variable, we use the Moran's I statistic using cross-sectional data for the years 2008–2017.

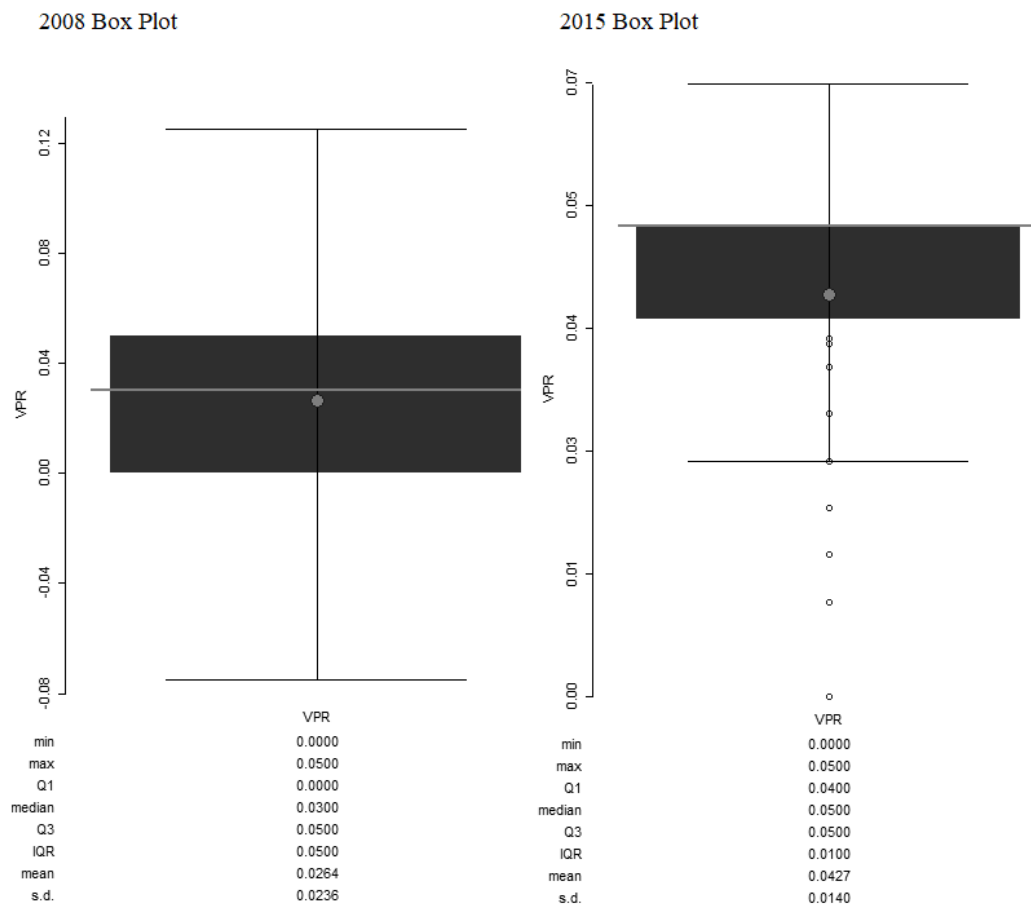
The Moran's I spatial statistical test is based on the spatial weights matrix, and it gives evidence for the presence of neighbourhood effects (Soro et al., 2016). The Moran's I statistic tests for spatial autocorrelation, to see whether phenomena cluster in certain areas occur or if data are spread-out randomly through space.

Firstly, as shown in Figure 2, we create a Box Plot to make sure our dependent variable follows a fairly normal distribution.

The larger circle represents the mean. The remaining, smaller, circles give us the range of the variable. The rectangular area is the interquartile (25% to 75%) range of values assuming the whiskers' distance is set equal to 1.5 times the interquartile range. The line in bold is the median. The black lines on the edges represent the reasonable extremes.. The circles outside the black lines are observations considered outliers.



**Figure 2**  
Box Plots for the variable participation rate



Source: Portuguese Tax Authority. GeoDa computations.

For the period 2008–2015, only the years 2015–2017 have outliers.<sup>2</sup> That seems to entail the data follows a normal distribution (it is only slightly skewed in the last three years).

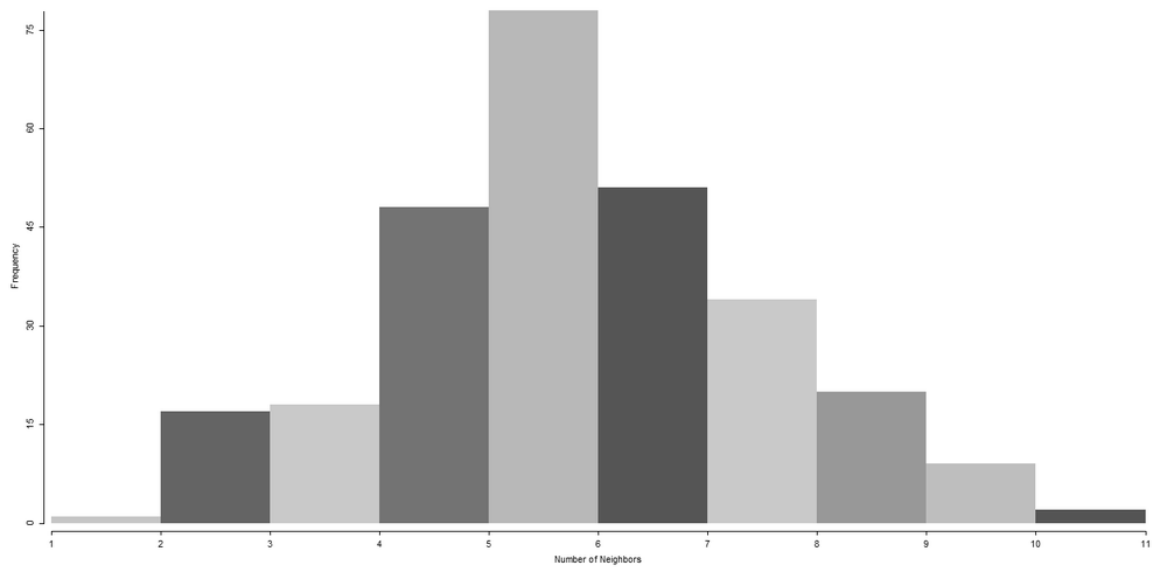
All the remaining variables in our study also follow a normal distribution in the considered period (calculations performed in Statistica). If our data was skewed, problems related to error variance and standard errors could arise (Stieve, 2012).

<sup>2</sup> The Box Plot for VPR of 2008, left-hand panel (in Figure 2 above), is illustrative of the period without outliers (2008–2014), while the Box Plot for VPR of 2015, right-hand panel is illustrative of the period with outliers (2015–2017).

To see whether there are spatial effects in the variable participation rate, we generated a spatial weights matrix in the Queen contiguity form (of the order 1 type) using the GeoDa software.

As we can see in Figure 3, which depicts the number of neighbours and their frequency, our spatial weights also follow a normal distribution. Table 5 presents a summary characterization of the spatial weights matrix. The spatial weights matrix is comprised of 278 cross-sectional spatial units (all Portuguese mainland municipalities). It has been row-normalized and it has a mean of approximately 5.3 contiguous units. The municipality “Nazaré” only has 1 neighbour, while “Santarém” and “Viseu” have 10 neighbours each.

**Figure 3**  
Spatial Weights Histogram



Source: GeoDa computations.

**Table 5**

Summary of the spatial-weights matrix

<b>Dimensions</b>	
278 x 278	
<b># of links</b>	<b>Observations</b>
1	1
2	17
3	18
4	48
5	78
6	51
7	34
8	20
9	9
10	2
Total	278
<b>Matrix Links</b>	
Min	1
Max	10
Mean	5.309353
Total	1476

Source: Stata computations.

In Table 6, we present the results from the Moran's I test for our dependent variable – the variable participation rate of the Personal Income Tax (VPR), for each individual year for the period 2008–2017.

The test is significant in only 6 out of the 10 years considered (2008, 2009, 2010, 2013, 2014 and 2017). That means that in 2011, 2012, 2015 and 2016, the spatial distribution of the variable participation rate values seems to be the result of random spatial processes. Moreover, even in the years for which there is evidence of spatially clustered values, test results show that there is a fairly low spatial autocorrelation pattern. In fact, the average Moran's I spatial autocorrelation value for the 6 years with significant values is of a mere 0.0953. Since our spatial weights matrix has been row-normalized, a result of 0 would mean a purely random clustering pattern (Stieve, 2012).

**Table 6**

Moran's I test for the dependent variable

VPR	Moran's I
2008	0.0845545 (2.4743)***
2009	0.101784 (2.8747)***
2010	0.0696371 (2.0797)**
2011	0.0363207 (1.1098)
2012	0.00448471 (0.2380)
2013	0.135455 (3.6179)***
2014	0.104655 (2.9357)***
2015	0.0110266 (0.4447)
2016	0.0216895 (0.7347)
2017	0.0757205 (2.1244)**

In parenthesis are the z-statistics.

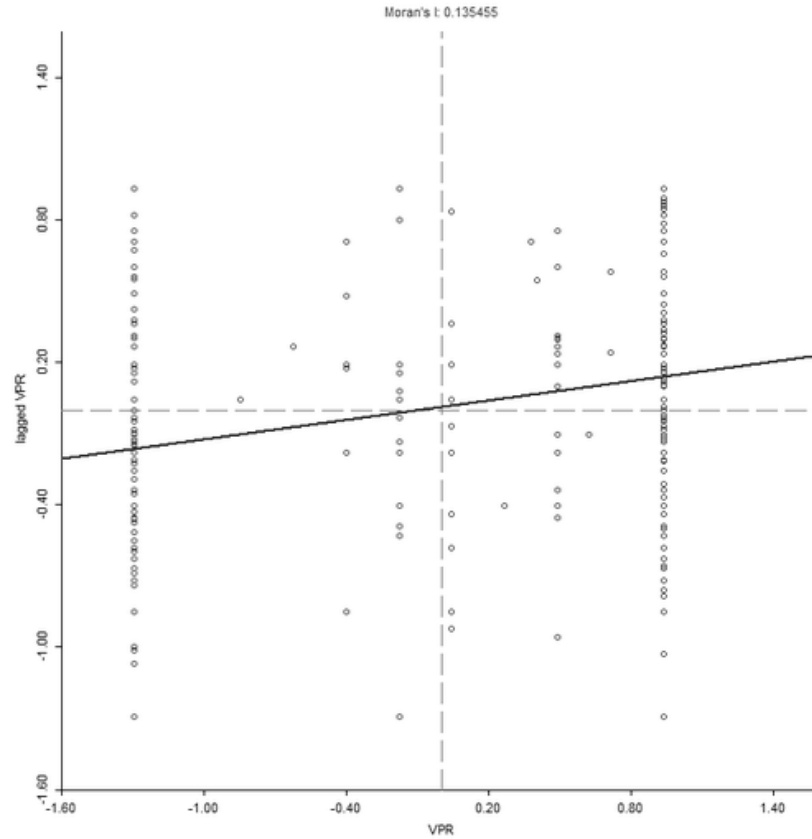
\*\*\* Statistically significant at the 0.01 level.

\*\* Statistically significant at the 0.05 level.

Source: Portuguese Tax Authority. Own calculations (using GeoDa).

In Figure 4, we include the Moran Scatter Plot for the year 2013, which is the year with the highest spatial autocorrelation for the variable participation rate of the Personal Income Tax (VPR).

**Figure 4**  
Moran Scatter Plot (VPR 2013)



Source: Portuguese Tax Authority. Own calculations (using GeoDa).

Complementarily, we use the Local Indicators of Spatial Association (LISA) statistic to understand the spatial location of the clusters in continental Portugal.

Figure 5 displays the LISA cluster maps for the years 2010 and 2013 (which correspond to the years of the lowest and highest significant values for the Moran's I statistic, respectively). It shows the presence of significant spatial clusters for the variable participation rate of the Personal Income Tax. Clusters of neighbouring municipalities exhibiting high rates are marked in red; clusters of neighbouring municipalities exhibiting low rates are marked in blue; clustering between municipalities with low rates and municipalities with high rates are marked in purple; whereas clustering between municipalities with high rates and municipalities with low rates are marked in pink.

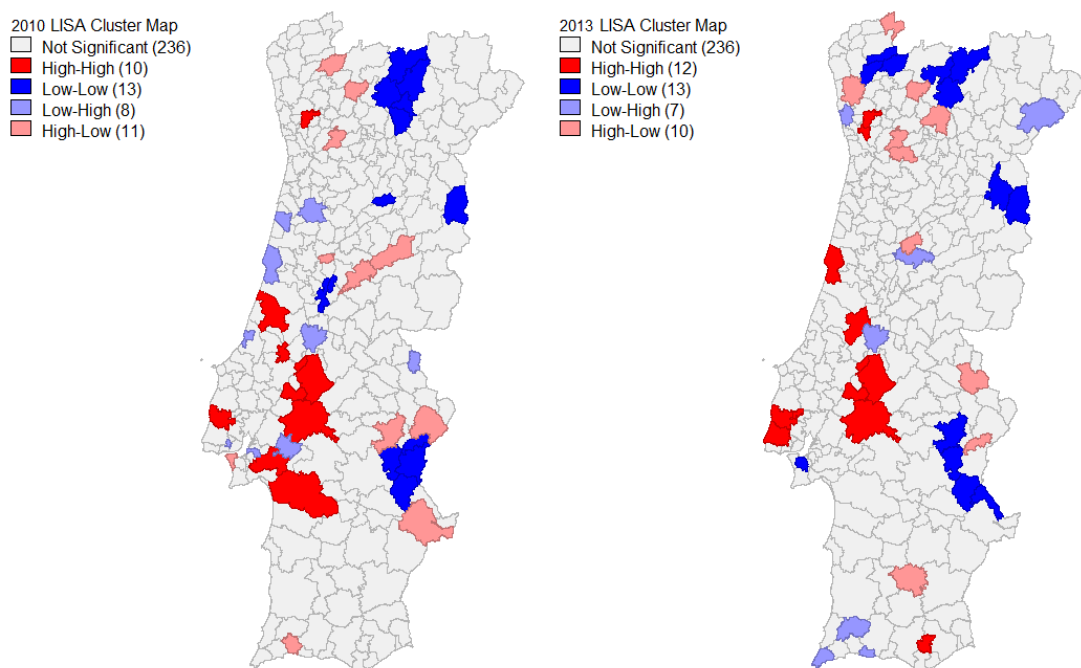
Taking the period 2008–2017 in its entirety, the clustering undergoes changes in location and type over time. However, we can point to persistent clustering of municipalities in the northern region (mainly associated with low rates), in the eastern

part of the centre region, in Lisbon and Tagus Valley regions (mainly associated with high rates), and in the eastern part of the “Alentejo” region.

Since spatial autocorrelation generally implies spatial clustering (Pisati, 2012), it is worthwhile pointing out that the municipalities which do not experience significant spatial clustering in their participation rates are the vast majority. In fact, for the period 2008–2017, the number of municipalities associated with non-significant LISA statistic values range from 232 to 253 and thus, on average, 86.7% of municipalities do not exhibit significant clustering.

Nevertheless, as can be seen in the maps in Figure 5, there is some evidence that participation rates might be spatially correlated. To test whether the detected neighbourhood effects can be attributed to strategic interactions between Portuguese municipalities, we make use of spatial panel data models, whose regressions are able to incorporate the spatial dependence through the generated spatial weights matrix.

**Figure 5**  
LISA Cluster Maps



Source: Portuguese Tax Authority. Own calculations (using GeoDa).

## 4.2. Data and descriptive statistics

The purpose of our study is to test whether there is evidence of fiscal strategic interactions between Portuguese municipalities for the municipalities' variable participation rate in the Personal Income Tax.

The following empirical research covers the period 2008–2015. As mentioned above, the spatial units are all the 278 mainland municipalities of Portugal. Data for each year was obtained from the Portuguese Tax Authority, the Directorate-General for Local Authorities, Statistics Portugal, and Institute of Employment and Professional Training (IEFP).

The dependent variable of our study is the municipalities' variable participation rate in the Personal Income Tax.

The set of covariates in the analysis include interjurisdictional, fiscal and socio-demographic variables as explanatory factors: the Neighbouring Variable Participation Rate, the Income Tax Transfers, the Unconditional Transfers, the Population Density, the Dependency Ratio, the Percentage of Registered Unemployment, and the Average Monthly Earnings.

The Neighbouring Variable Participation Rate is the average participation rate in the Personal Income Tax of the municipalities that share a geographical border with the municipality. The coefficient of this interjurisdictional explanatory variable captures the degree of spatial strategic interactions when municipalities decide on their own participation rate (Kangasharju et al., 2006; Baskaran, 2014). In other words, this variable allows to measure whether municipalities take into consideration the rates set by neighbouring municipalities (Costa et al., 2011; Lyytikäinen, 2012). If the variable's estimated coefficient is statistically significant with a positive sign, and the model's spatial dependence parameters are both positive and significant, there is evidence of tax mimicking: an increase in the neighbours' participation rates leads to a strategic increase in the municipality's own participation rate. On the other hand, if the estimated coefficient has a negative sign, there is no evidence of tax mimicking: an increase in the neighbours' participation rates leads to a decrease in the municipality's own participation rate. In other words, for there to be strategic interaction among municipalities, a change in the

participation rate of neighbouring municipalities has to lead to a change in the same direction in the municipality's own participation rate (Costa et al., 2011).

The remaining variables are introduced in the model to control for municipalities' fixed fiscal and socio-demographic local characteristics.

The Personal Income Tax Transfers variable captures the per capita transfers received from the central government related to the 5% participation rate in IRS (its amount is collected from the municipality's residents). This fiscal variable is a proxy of the municipality's relative tax base capacity. Municipalities with higher income residents are more able to set higher tax rates (Costa et al., 2011). We expect this variable's estimated coefficient to have a positive sign.

The Unconditional Transfers variable is the total per capita unconditional transfers received by the municipality from the central government, which include unconditional current transfers and unconditional capital transfers. Municipalities that experience an increase in the amount of per capita unconditional transfers become less dependent on their own fiscal revenue, enabling municipalities to set lower tax rates (Costa et al., 2011; Padovano and Petrarca, 2014). We expect this fiscal variable's estimated coefficient to have a negative sign.

The Population Density variable is calculated as the total individuals by square kilometre. This socio-demographic variable can be seen as a proxy for agglomeration economies. Highly populated municipalities benefit from urban agglomeration economies, and therefore are more able to set higher tax rates (Costa et al., 2011). We expect this variable's estimated coefficient to have a positive sign.

The Dependency Ratio variable is calculated as the sum of the resident population aged 0 to 14 years and the resident population aged 65 and over, divided by the working age population (the resident population aged 15 to 64 years). This variable captures the municipality's social vulnerability. Municipalities whose residents are more socially vulnerable have less ability to set higher tax rates (Costa and Carvalho, 2013). On the other hand, municipalities with high dependency ratios also have higher costs (as we have discussed, Portuguese municipalities are responsible for offering services – such as childcare and leisure centres – that ensure the well-being of these two groups) and are thus expected to set higher tax rates (Costa et al., 2011). Because of that, the predicted sign of this socio-demographic variable is ambiguous (Padovano and Petrarca, 2014).



The Percentage of Registered Unemployment variable is the number of unemployed individuals registered in local employment centres as a proportion of the resident population aged 15 or more. This socio-demographic variable also captures the dimension of social vulnerability in the municipality, since it affects the ability of residents to pay taxes. Thus, municipalities with high registered unemployment are less able to set higher tax rates. We expect this variable's estimated coefficient to have a negative sign.

Similarly to Income Tax Transfers, the variable Average Monthly Earnings is also a reflection of the municipality's relative tax base capacity. An increase in the monthly earnings of the municipality's taxpayers means the tax base also increases. Municipalities with higher income residents are more able to set higher tax rates (Costa et al., 2011). We expect this socio-demographic variable's estimated coefficient to have a positive sign.

Table 7 lists the description and the data sources of each variable used in our study.

**Table 7**  
Variables used in the study

Variable	Description	Source
VPR	Variable participation rate in Income Tax of the municipality	Portuguese Tax Authority
NVPR	Mean variable participation rate in the neighbouring municipalities	Own Calculations
T_IRSpc	Income Tax Transfers received by the municipality, €/per capita	Directorate-General for Local Authorities
UTpc	Total Unconditional Transfers received by the municipality, €/per capita	Directorate-General for Local Authorities
PopD	Population Density in the municipality	Statistics Portugal
Dr	Total Dependency ratio in the municipality	Statistics Portugal
UActive	Percentage of registered unemployment in the municipality	IEFP and Statistics Portugal
AvME	Average monthly earnings in the municipality	Statistics Portugal

Following Lyytikäinen (2012), our empirical analysis is based on a model where all explanatory variables are lagged one period ( $t-1$ ) except for the Neighbouring Variable Participation Rate. In doing so, we are assuming municipalities respond to contemporaneous tax rate changes from their neighbours. We believe this assumption accurately represents the Portuguese institutional setting.

Most municipalities set their participation rate in the Personal Income Tax in the months of September to December. Moreover, municipalities can react to their

neighbours' tax rates decisions by revising their participation rate – changing it accordingly.<sup>3</sup> This gives us good grounds to assume strategic interactions occur simultaneously and not with one year lag.

By lagging all the other explanatory variables one period, we are assuming that when municipalities decide on their participation rates, they are using mostly current information that is available to them.

Table 8 includes the summary statistics of the variables used in the model.

**Table 8**  
Summary statistics of the variables (2008–2015)

Variables	Min			Max			Mean	SD		
	Within	Between	Overall	Within	Between	Overall		Within	Between	Overall
VPR	-0.013408	0	0	0.074092	0.05	0.05	0.030342	0.0150144	0.0168009	0.0225126
NVPR	-0.010376	0.009375	0	0.070874	0.05	0.05	0.030249	0.0085615	0.0084586	0.0120259
T_IRSpc	-40.37372	2.315744	0	84.38974	101.2203	128.598	21.24411	4.303617	13.426	14.07874
UTpc	-609.6063	3.956522	0	706.2858	2088.869	2203.548	471.7655	51.93488	360.6897	363.847
PopD	-687.4872	4.975	4.4	737.6128	7378.712	7397.7	309.7628	39.06428	856.5269	856.069
Dr	0.5076974	0.384125	0.374	0.6888224	1.0725	1.088	0.5920724	0.0160953	0.1150945	0.1160349
UActive	0.0095719	0.0200618	0.0117918	0.1025033	0.1144978	0.1404722	0.0570996	0.0124417	0.0174759	0.0214299
AvME	548.1414	665.3062	582.91	1235.813	1686.083	1883	851.3602	49.91441	150.5514	158.385

Source: Stata computations.

The Overall variation gives us the variation over time and municipalities, the Between variation gives us the variation between municipalities (from one municipality to another), and the Within variation gives us the variation over time within municipalities.

For our dependent variable, VPR, the mean is 0.03. The minimum and maximum give us the rate margin (0 and 0.05). The Overall standard deviation is 0.0225, the Between standard deviation is 0.0168 and the Within standard deviation is 0.015. The variable participation rate has higher between variation (rate variation from one municipality to another) than within variation (rate variation of a municipality over time).

In the regressions, in order to mitigate the scale effect, all variables that are not in percentage form have been transformed using the logarithm function (Costa and Carvalho, 2013).

<sup>3</sup> Click [here](#) to see the municipalities' revised rate values for each year.

### 4.3. Analysis of the empirical results

Six models were estimated using the Stata software.<sup>4</sup>

Model 1 is the Pooled OLS model, a non-spatial panel model (the spatial weights matrix is not used in this model). We estimate it mainly to see whether controlling for spatial dependence in the spatial panel models yields improvements.

Model 2 is the SDM model, Model 3 is the SAR model, Model 4 is the SEM model, Model 5 is the SAC model – a combination of Models 3 and 4 –, and Model 6 is the GSPRE model. The spatial panel models are fitted using the QML estimation method.

The better choice between these spatial econometric models depends on the type of spatial interaction effects to be accounted for (spatially lagged dependent variable; spatially lagged independent variables; spatially autocorrelated error term; or a combination of these) and whether or not spatial specific and/or time specific effects should be accounted for (and whether to treat them as fixed or random effects) (Elhorst, 2014).

Models which introduce spatial fixed-effects prevent the “interference of local specificities in the evaluation of the spatial interaction factor” (Costa and Carvalho, 2013: 19) and only use the time-series data; whereas time fixed-effects are used to control for all period-specific spatial-invariant variables (Reulier and Rocaboy, 2009). Models without such controls use both time-series and cross-sectional data (Elhorst and Fréret, 2009).

To decide between the fixed-effects and random-effects variants, a robust version of the Hausman (1978) statistic test was performed for the SDM, SAR and SEM models. The robust Hausman test results are shown in Table 9.

Results from the robust Hausman tests indicate that, for our panel data analysis, the fixed-effects variant is always the appropriate choice: we strongly reject the null

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<sup>4</sup> The use of software to estimate spatial panel data models was not without its challenges. While there is the option of using routines in Matlab, the `splm` package in R, or the `xsmle` command in Stata, the amount of resources that show empirical researchers the skills and techniques needed to use any of the spatial panel econometrics software packages is still limited. With that in mind, I made a YouTube tutorial on "How to Estimate Spatial Panel Data Models in Stata", with the creation and managing of the spatial weights matrix being done first in GeoDa (click [here](#) for a link to the video). The tutorial is a by-product of the empirical work developed in this dissertation. I am humbled by the reception the video has received so far.

hypothesis that differences in coefficients of the random-effects variant are not systematic; the alternative hypothesis being that the fixed-effects variant is consistent and the random-effects variant is inconsistent.

As for the SAC model, we estimate the fixed-effects variant because “the literature focuses on the fixed-effects variant of this specification as the random-effects variant can be written as a special case of the SAR specification” (Belotti et al., 2017: 3). The GSPRE cannot be estimated with the fixed-effects variant.

In our spatial fixed-effects estimates, the data has been transformed according to Lee and Yu (2010) to yield consistent QML estimators with properly centred distributions.

The regressions include robust standard errors estimations and robust variance estimations which accurately take into account the cluster-correlated data, by adjusting for within-cluster correlation. The robust variance used goes under the names “Huber (1967)/White (1980)/sandwich” estimate of variance.

**Table 9**  
Robust Hausman test results

Spatial Panel Model	Hausman test
SDM	Prob $\geq$ chi2 = 0.0000 chi2(15) = 51.00
SAR	Prob $\geq$ chi2 = 0.0000 chi2(8) = 47.70
SEM	Prob $\geq$ chi2 = 0.0024 chi2(8) = 23.92

Source: Stata computations.

To find the spatial panel model that better fits the data, we use the strategy described in Belotti et al. (2017).

As we have seen in section 3.3., the SDM model structure is the following:

$$y_t = \rho W y_t + X_t \beta + W Z_t \theta + \mu + \epsilon_t \quad (6)$$

It can be shown that if  $\theta = 0$  and  $\rho \neq 0$  (null hypothesis), the model is a SAR (Belotti et al., 2017). Performing the test, we strongly reject the null hypothesis, with a p-value lower than one percent.

On the other hand, if  $\theta = -\beta\rho$  (null hypothesis), the model is a SEM (Belotti et al., 2017). Performing the test, we again strongly reject the null hypothesis, with a p-value lower than one percent.

For now the SDM seems to be the better fit for our data.

To decide whether the SAC model is a better fit, we use the Akaike's information criterion (AIC) and the Bayesian information criterion (BIC) for both the SAC and SDM models: given two models fitted on the same data set, the larger the value of these measures, the worse the model is considered to fit. Results show the SDM model to be a slightly better fit for our data (see Table 10).

Finally, to compare the SDM and GSPRE models, we also look at their AIC and BIC measures. AIC and BIC results indicate the GSPRE model to better fit the data (though again only slightly – see Table 10).

Altogether, the tests point to a spatial fixed-effects SDM and to the GSPRE model. The estimation results are given in Table 10.

The variable Neighbouring Variable Participation Rate has, as expected, positive estimated coefficients in every model, except in the SDM.

In every spatial panel model, however, the variables introduced to control for municipalities' fixed fiscal and socio-demographic local characteristics have no statistically significant effect on participation rates, except for Population Density in the SDM (where it has, as expected, a positive estimated coefficient).

Looking at the Table 10 results, the overall R-squared for each of the models is fairly small (the average overall R-squared for the 6 panel models is a mere 0.059). The two previous papers that have studied our dependent variable (the variable participation rate in the Personal Income Tax) – Coimbra et al. (2011) and Costa et al. (2011) – believe their estimation results for this variable may have been influenced by the small amplitude of the rate. Because the model with the highest overall R-squared is the non-spatial Pooled OLS model (with the R-squared of 0.1103 and the adjusted R-Squared of 0.1075), we believe that can be seen as an indication that accounting for spatial dependence may not be adequate for our data.

**Table 10**  
Panel estimation results for the IRS variable participation rate

Variables	(1) Non-spatial Panel Model	(2) Spatial Panel Model: SDM		(3) Spatial Panel Model: SAR	(4) Spatial Panel Model: SEM	(5) Spatial Panel Model: SAC	(6) Spatial Panel Model: GSPRE
	Pooled OLS	SDM with spatial FE		SAR with spatial FE	SEM with spatial FE	SAC with spatial FE	SEM with spatial autoregressive RE
		$\beta$ vector	$\theta$ vector				
NVPR	0.2943103 (7.44)***	-0.8001045 (-11.23)***	2.281385 (22.78)***	0.4774585 (9.71)***	1.111403 (42.28)***	1.087473 (34.69)***	1.09989 (14.54)***
T_IRSp	0.012286 (6.65)***	0.0014993 (0.89)	-0.000624 (-0.21)	0.0004389 (0.19)	0.000894 (0.57)	0.0008922 (0.57)	0.0029573 (0.40)
UTpc	0.0046337 (2.12)**	0.0015358 (0.57)	0.0046721 (0.95)	0.0019923 (0.59)	0.0024526 (1.00)	0.0024546 (1.00)	0.0011124 (0.10)
PopD	0.0013387 (0.86)	0.0720781 (2.44)**	0.0952976 (1.89)	-0.0714594 (-1.54)	0.0336709 (1.63)	0.0337347 (1.63)	0.0006722 (0.04)
Dr	-0.0095089 (-1.60)	0.0241225 (1.03)	-0.0169779 (-0.52)	0.025581 (0.84)	0.0116471 (0.77)	0.0116519 (0.77)	-0.0016406 (-0.02)
UActive	0.0391521 (1.65)*	-0.0093956 (-0.23)	0.0448991 (0.80)	0.0357114 (0.86)	0.0061598 (0.32)	0.006177 (0.32)	-0.0083323 (-0.07)
AvME	0.0413893 (4.89)***	-0.0251696 (-1.46)	-0.0157267 (-0.57)	0.0087709 (0.45)	-0.0139364 (-1.29)	-0.0139269 (-1.29)	-0.010094 (-0.18)
Constant	-0.1259204 (-4.56)***						0.0202922 (0.14)
Spatial Rho		-0.0022815 (-0.62)		0.0006958 (0.36)		0.0240339 (1.91)*	
Spatial Lambda					-1.107965 (-33.58)***	-1.108292 (-33.73)***	-1.097322 (-17.43)***
Spatial Phi							-1.135628 (-6.86)***
Variance (e)		0.0001146 (19.55)***		0.0002323 (19.75)***	0.0001433 (21.31)***	0.0001432 (21.36)***	0.012025 (18.14)***
Variance (mu)							0.0123651 (9.85)***
Mean of FE		-0.2350		0.1038	-0.0413	-0.0603	
Log-likelihood		6067.7874		5380.4381	5629.9499	6573.3649	6573.3531
Panel length (years)	8	7		7	7	7	8
Groups (municipalities)	278	278		278	278	278	278
Observations	2224	1946		1946	1946	1946	2224
AIC	-10807.73	-12103.57		-10742.88	-11241.9	-11240.12	-12205.62
BIC	-10762.08	-12014.4		-10692.71	-11191.74	-11184.38	-12137.14
Adj R-sq	0.1075						
R-sq: within		0.5553		0.0982	0.0891	0.0944	0.0900
between		0.0656		0.0474	0.0533	0.0544	0.0257
overall	0.1103	0.0611		0.0198	0.0543	0.0556	0.0510

In parenthesis are the t-statistics / z-statistics.

\*\*\* Statistically significant at the 0.01 level.

\*\* Statistically significant at the 0.05 level.

\* Statistically significant at the 0.10 level.

In an attempt to understand and possibly improve the estimation results for our dependent variable, we re-estimated the models relaxing the control variables that were initially used. We found that, no matter the combination of control variables we use, the general fit of the models remained virtually unchanged: the estimated coefficients remained very small (close to 0) and the R-squared, Log likelihood, and AIC/BIC of the regressions did not appear to improve. The exception to that was for the SDM estimates; while the impact of the control variables' coefficients remained nearly the same (close to 0) no matter what control variables we considered, when we consider a specification with only the covariate NVPR, the general fit of the model, judging by the R-squared, improved greatly – see Table 11 for the re-estimation results.

**Table 11**  
SDM re-estimation results for the IRS variable participation rate

Variables	SDM with spatial FE	
	$\beta$ vector	$\theta$ vector
NVPR	-0.8157468 (-11.27)***	2.158508 (22.45)***
Spatial Rho	-.0025463 (-0.72)	
Variance (e)	0.0001183 (19.99)***	
Variance (mu)		
Mean of FE	-0.0098	
Log-likelihood	6037.2454	
Panel length (years)	7	
Groups (municipalities)	278	
Observations	1946	
AIC	-12066.49	
BIC	-12044.2	
Adj R-sq		
<b>R-sq: within</b>	<b>0.5412</b>	
<b>between</b>	<b>0.5293</b>	
<b>overall</b>	<b>0.5306</b>	

In parenthesis are the t-statistics / z-statistics.

\*\*\* Statistically significant at the 0.01 level.

Source: Stata computations.

Considering the spatial dependence factors of the spatial regressions, the SDM specification, including the re-estimated SDM, has a negative and statistically insignificant spatial interaction factor (given by its Spatial Rho); the SAR specification has a positive but statistically insignificant spatial interaction factor (given by its Spatial Rho); the SEM specification has a negative statistically significant spatial interaction

factor (given by the Spatial Lambda); the SAC specification has a positive and statistically significant Spatial Rho and a negative statistically significant Spatial Lambda; and the GSPRE specification has negative statistically significant interaction factors (given by its Spatial Lambda and Spatial Phi).

These spatial dependence parameters (given by the Spatial Rho, Spatial Lambda and Spatial Phi, depending on the model considered) reflect the spatial dependence present in our data set. They measure the average influence of the neighbouring municipalities on a given municipality (GIS Institute, 2017).

Allers and Elhorst (2005) interpret a positive and significant Spatial Rho as evidence of tax mimicking, while Bordignon et al. (2003) interpret a positive and significant Spatial Lambda as evidence of tax mimicking.

From the results of the variable Neighbouring Variable Participation Rate, there is a clear relationship between neighbouring municipalities' tax rates: the estimates are highly significant and have the expected positive sign in every model, except in the SDM with spatial fixed effects.

However, these neighbouring effects, in the absence of significant spatial effects, only capture the fact that there are significant differences between participation rates among municipalities (Kangasharju et al., 2006), and thus do not provide evidence of strategic interactions. Otherwise, the Pooled OLS model would be sufficient to assert the existence of strategic interactions. Indeed, for the spatial effect of strategic interaction to be captured (i.e., the effect of change in the neighbouring participation rates on the municipality's own participation rate), the spatial panel models have to yield positive significant spatial dependence factors.

From the five spatial panel models considered, the only model with a positive statistically significant spatial dependence factor is the SAC model, with a small yet significant Spatial Rho of 0.024 (see Table 10).

Coimbra et al. (2011) interpret a positive and significant Spatial Rho (even in the presence of a negative coefficient for the Spatial Lambda) in the SAC model as evidence of strategic interaction. Thus, we find some empirical evidence of spatial strategic interaction occurring among Portuguese municipalities in the case of the variable participation rate in the Personal Income Tax. In the SAC specification, municipalities seem to take into consideration the participation rates of neighbouring municipalities



when deciding on their own participation rates: a percentage point increase in the average neighbouring municipalities' participation rates leads to a 1.087 percentage point increase in the municipality's own participation rate.

It must be pointed out, however, that the SAC's Spatial Rho coefficient is objectively small. Moreover, from the model selection analysis described above, the SAC model does not appear to be the best fit for our data; the SDM and GSPRE models seem to perform better. Estimates from the SDM and GSPRE models reveal a negative influence of spatial dependency factors. Both these models provide no evidence of strategic interactions. Moreover, the NVPR estimates are contrary to expected sign in the case of the SDM.

## Conclusions

The present study attempted to assess the existence of fiscal strategic interactions between the 278 municipalities of mainland Portugal for the variable participation rate in the Personal Income Tax, covering the period 2008–2015.

Considering the current Portuguese institutional framework and the inherent high visibility nature of the personal income tax, we believe that the most likely driver of the possible strategic interactions is, *a priori*, yardstick competition. The 5% maximum tax margin in the variable participation rate in the Personal Income Tax is unlikely to be large enough to trigger significant inter-jurisdictional migratory movements, making tax and welfare competition unlikely drivers of strategic interaction. Likewise, expenditure spillovers are not likely to be a driver of strategic interaction, since the 5% maximum participation of municipalities in the tax revenue does not have a large enough impact in the financing of local expenditures to trigger a spillover effect.

For the period 2008–2017, a preliminary spatial analysis provides some evidence of spatial effects and of spatial clustering for the municipalities' participation rate of the Personal Income Tax. The Moran's I statistic indicates the presence of significant neighbourhood effects for the years 2008, 2009, 2010, 2013, 2014 and 2017. However, the average spatial autocorrelation for these six years is merely of 0.0953 (a result of 0 would indicate a random pattern in the clustering). The Local Indicators of Spatial Association (LISA) statistic points to significant spatial clustering of participation rate values in, on average, 13.3% of Portuguese mainland municipalities.

To test whether neighbourhood effects can be attributed to strategic interactions between Portuguese municipalities, we estimated different spatial panel data models.

Overall, estimation results show no statistically significant positive spatial dependence parameters, and thus provide no empirical evidence of strategic interactions. Only in the SAC specification do we find a positive and statistically significant spatial dependence factor. This provides us some empirical evidence of spatial strategic interaction occurring among Portuguese municipalities in participation rates: a percentage point increase in the average neighbouring municipalities' participation rates leads to a 1.087 percentage point increase in the municipality's own participation rate. It is, however, very important to put this result into perspective. From a model selection

analysis, the SAC model is not the best fit for our data. Moreover, its positive spatial dependence factor's coefficient is a mere 0.024. That, together with the weak spatial autocorrelation results from the Moran's I and LISA statistics, make us reticent about the appropriateness of pointing to strategic interactions in variable participation rates. Our results are aligned to those of Coimbra et al. (2011): using 2009 cross-sectional data, only the SAC specification provided evidence of strategic interactions among Portuguese municipalities when deciding on the variable participation rate.

With fiscal decentralization at the centre of the current Portuguese policy agenda, we believe understanding whether strategic interaction is a real phenomenon is not only of academic interest but can also help reformists design a better institutional framework. Since one of the objectives of the current Local Finance Law (Law 73/2013, September 3<sup>rd</sup>) is to improve inter-municipal fiscal competition and electoral accountability, our results work as an assessment tool for forthcoming decentralization policies.

We believe that the estimation results concerning the variable participation rate in the Personal Income Tax may be related to the small amplitude of the rate margin. Indeed, a 5% margin for municipalities to set their participation rates does not seem enough to justify a wide range of different rate values (for example, in 2017, 42% of municipalities decided on a 5% rate). Should the 5% rate margin be increased by Law, the relative importance of the participation rate would increase for both local politicians (mayors would have the opportunity to further increase their tax revenues) and people within each municipality (the higher the rate margin, the more likely residents are to pressure mayors into aligning their participation rates with those of neighbouring municipalities). Thus, assuming a high perception of this local rate, increasing the maximum rate could spark spatial clustering and strategic interactions over time, with an expected corresponding increase in electoral accountability through the yardstick mechanism, similar to other Portuguese local taxes: the Municipal Tax on Real Property, the municipal surcharge on Corporate Income Tax and the Municipal Tax on Real Property, as evidenced in Costa et al. (2011) and Costa and Carvalho (2013).

Some suggestions for future research include the use of alternative spatial weights matrix specifications, as well as the assumption that strategic interactions do not occur simultaneously, but with a time lag, allowing for slower reactions to neighbours' variable participation rate changes.

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